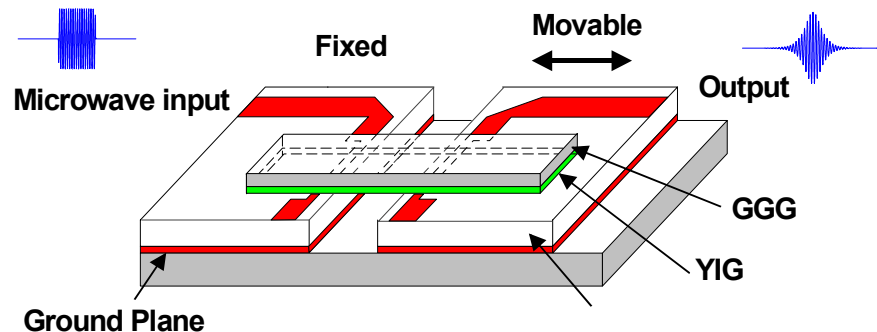


From Solitons to Precessional Dynamics and Chaos - Nonlinear Spin Waves in Magnetic Thin Films

Carl E. Patton, Department of Physics, Colorado State University
(DMR-0108797)

Solitons are robust nondispersive pulses that may be used for high data rate communications, radar, and signal processing. Microwave solitons in thin magnetic films provide a unique avenue for the study of the fundamental nonlinear precession dynamics that make solitons work.

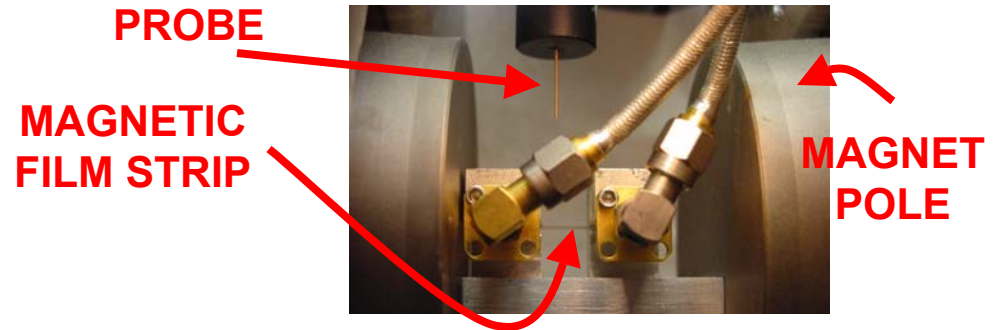
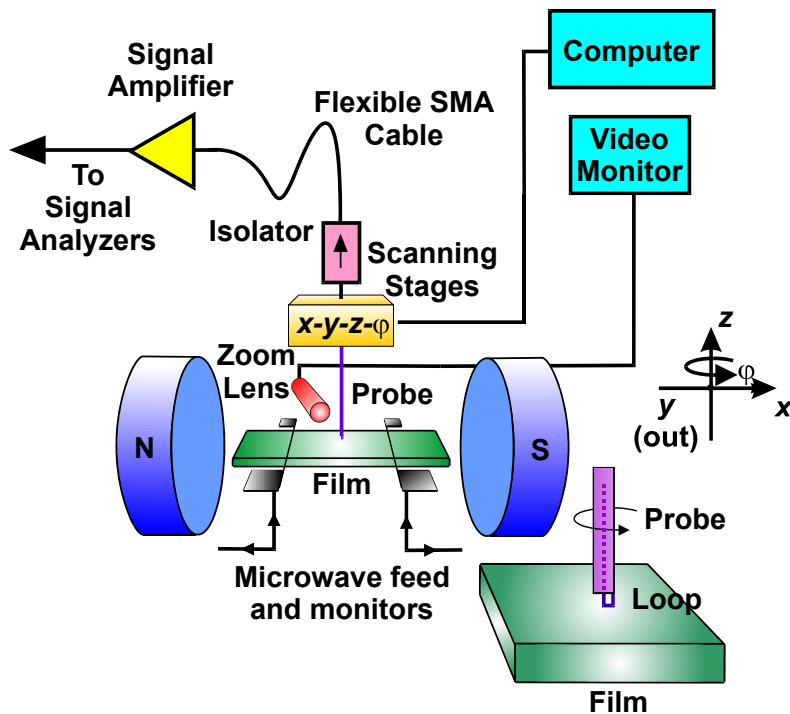
The structure: A thin single crystal yttrium iron garnet (YIG) film in the form of a narrow strip placed in a microstrip transducer structure.



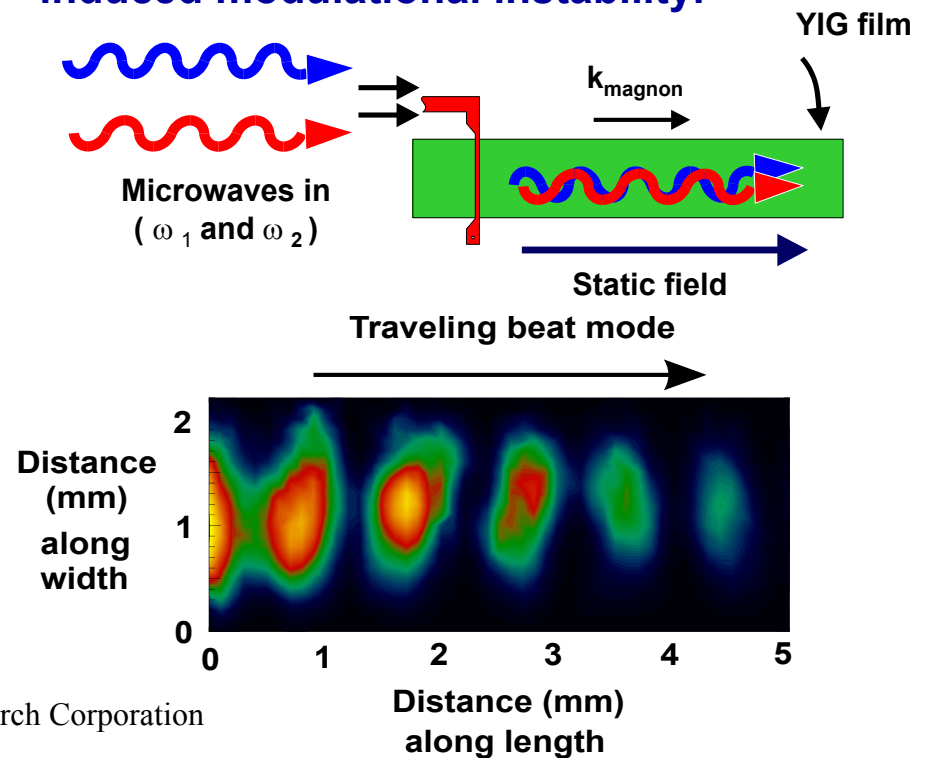
Fundamental phenomena: Soliton formation and propagation. Collisions. Nonlinear decay. Solitons in feedback systems - trains and self generation. Higher order solitons.
Applications: Digital pulse coded transmission lines. Secure communications

Time and space resolved inductive magnetodynamic probe (IMP) soliton measurement system:

IMP system

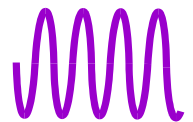
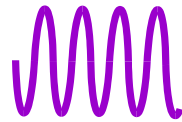


Soliton trains by CW mode beating and induced modulational instability.



IMP results courtesy of Dr. Mark Scott, now at Mission Research Corporation

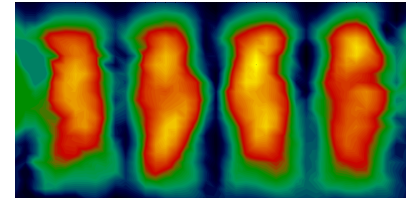
antenna positions not to scale



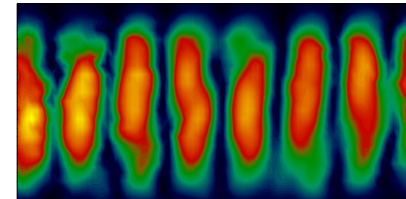
CW magnetostatic
backward volume wave

standing wave

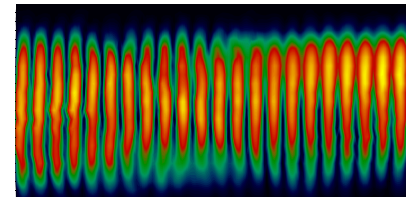
mode beating



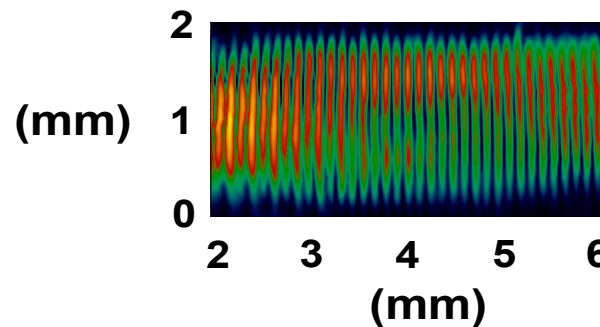
$\lambda = 2.025$ mm
 $f = 5371$ MHz



$\lambda = 1.414$ mm
 $f = 5365$ MHz



$\lambda = 0.515$ mm
 $f = 5338$ MHz



$\lambda = 0.320$ mm
 $f = 5313$ MHz

Personnel and Recent Accomplishments

Carl E. Patton (PI)

Award - IEEE Magnetics Society Lifetime Achievement Award 2003

(Awarded April 2003 at Toronto Intermag.

Invited lecture (most recent): Parametric Pumping, Nonlinear Spin Waves, and Spin Wave Instability in Permalloy Films, presented at the Summer Meeting of the National Storage Industry Consortium, 26 June 2003.



Spin wave nonlinear dynamics in thin films:

First butterfly curve measurements in permalloy films.

First resonance saturation butterfly curve analysis

First comprehensive thin film spin wave instability theory.

Microwave magnetic envelope solitons:

First measurements of soliton recurrence.

First quantitative measurements of nonlinear damping and decay coefficients.

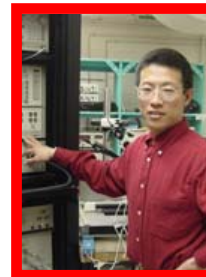
First measurements of dark solitons for an attractive nonlinearity.

First measurements of higher order soliton formation and decay.

First quantitative measurements of soliton interaction in collision.



Boris Kalinikos
Guest Scientist



Mingzhong Wu
Postdoctoral Fellow



Pavol Krivosik
Postdoctoral Fellow



Michael Kraemer
Ph .D. Candidate



Tony Gorges
Ph. D. Student



Heidi Olson
Ph. D. Student